What is claimed is:

1. A method of optimizing a response of a gas correlation radiometer to a trace amount of a target gas present in the free atmosphere along a detection path to the gas correlation radiometer, wherein the detection path may also contain at least one competitive other gas the presence of which in the free atmosphere may interfere with detection of the trace amount of the target gas, the gas correlation radiometer using an infrared filter for the response, the method comprising the operations of:

determining an absorption spectrum of the target gas modeled according to field parameters;

determining an absorption spectrum of the at least one competitive gas modeled according to the field parameters;

determining similarity and contrast between the absorption spectra of the atmosphere and of the target gas;

determining differences between respective values of contrast and similarity corresponding to a plurality of band passes and center wavelengths of possible infra red filters;

for each of the plurality of band passes, plotting the differences as a function of center wavelength; and

optimizing the infrared filter to be used in the gas correlation radiometer by selecting a combination of infrared filter center wavelength and band pass that results in the largest value of contrast minus similarity for the trace gas present in the free atmosphere along the detection path containing the at least one competitive other gas.

2. A method as recited in claim 1, further comprising the operation of:

mounting the optimized infrared filter in the gas correlation radiometer.

3. A method as recited in claim 1, wherein the at least one competitive gas is water vapor and wherein the determining of the second absorption spectrum determines the second absorption spectrum corresponding to the water vapor.

4. A method as recited in claim 1, wherein the at least one competitive gas is water vapor and another gas, and wherein the determining of the second absorption spectrum determines the second absorption spectrum corresponding to both the water vapor and the another gas.

5. A method as recited in claim 1, wherein the method optimizes respective responses of each of two gas correlation radiometers to trace amounts of the respective target gases ethane and methane present in the free atmosphere along the detection path to the two gas correlation radiometers, wherein for the gas correlation radiometer for ethane detection the at least one competitive gas is a gas other than the ethane; wherein for the gas correlation radiometer for methane detection the at least one competitive gas is a gas other than the respective methane; the method further comprising:

performing the method of claim 1 once with respect to ethane as the target gas and once with respect to methane as the target gas so that there are provided two optimized infrared filters each having the selected center wavelength and bandwidth for use with the respective ethane and methane gas correlation radiometers to filter light transmitted through the free atmosphere to the respective ethane and methane gas correlation radiometers.

6. A method of optimizing a response of a gas correlation radiometer to a trace amount of a target gas present in the free atmosphere along a detection path to the gas correlation radiometer, wherein the detection path may also contain at least one competitive other gas the presence of which in the free atmosphere may interfere with detection of the trace amount of the target gas, the method comprising the operations of:

identifying a spectral region of a first absorption spectrum of the target gas, the spectrum corresponding to selected parameters of target gas concentration, target gas temperature, target gas pressure, and path length through the target gas, the spectral region having a plurality of high absorption characteristics and low absorption characteristics

for the spectral region, providing a second absorption spectrum of the at least one other competitive gas, the second absorption spectrum corresponding to the selected parameters and including non-absorbing regions corresponding to the low-absorption characteristics of the first absorption spectrum;

determining a set of similarity data as a function of overlap regions within the spectral region, the overlap regions being for each of the at least one other

competitive gas and the target gas and being those regions within the spectral region in which the respective absorption spectra of both the target gas and the at least one other competitive gas have absorption characteristics, the set of similarity data including a plurality of data items within each of a plurality of bandwidths, one of the data items corresponding to a center wavelength within each bandwidth;

determining a set of contrast data as a function of non-overlap regions within the spectral region, the non-overlap regions being for each of the at least one other competitive gas and the target gas and being those regions within the spectral region in which the first absorption spectrum has high absorption characteristics but the second absorption spectrum has low absorption characteristics, the set of contrast data including a plurality of data items within each of a plurality of bandwidths, one of the data items corresponding to a center wavelength within each bandwidth;

preparing a graph corresponding to each of the bandwidths, each graph being a plot of the data points, each data point having an ordinate axis value based on a contrast data item minus a similarity data item, each data point having an abscissa axis value based on one of the center wavelengths;

from one of the prepared graphs, selecting as a center wavelength of an infrared filter for use with the gas correlation radiometer the center wavelength corresponding to the highest value of the contrast data item minus the similarity data item of all of the graphs;

selecting as the bandwidth of the infrared filter the bandwidth corresponding to the graph having the highest value of the contrast data item minus the similarity data item of all of the graphs; and

providing the infrared filter having the selected center wavelength and bandwidth for use with the gas correlation radiometer to filter light transmitted through the free atmosphere to the gas correlation radiometer.

7. A method as recited in claim 6, wherein the at least one competitive gas is water vapor and wherein the providing of the second absorption spectrum provides the second absorption spectrum corresponding to the water vapor.

8. A method as recited in claim 6, wherein the at least one competitive gas is water vapor and another gas, and wherein the providing of the second absorption spectrum provides the second absorption spectrum corresponding to both the water vapor and the another gas.

9. A method as recited in claim 6, wherein the method optimizes respective responses of each of two gas correlation radiometers to trace amounts of the respective target gases ethane and methane present in the free atmosphere along the detection path to the two gas correlation radiometers, wherein for the gas correlation radiometer for ethane detection the at least one competitive gas is a gas other than the ethane; wherein for the gas correlation radiometer for methane detection the at least one competitive gas is a gas other than the respective methane; the method further comprising:

performing the method of claim 5 once with respect to ethane as the target gas and once with respect to methane as the target gas so that there are provided two optimized infrared filters each having the selected center wavelength and bandwidth for use with the respective ethane and methane gas correlation radiometers to filter light transmitted through the free atmosphere to the respective ethane and methane gas correlation radiometers.

10. A method as recited in claim 6, wherein the operation of determining the set of similarity data as a function of overlap regions within the spectral region is performed using Equation (1) below, wherein:

λ_2 and λ_1 define the bandwidth, T_{atm} is the wavelength-dependent optical transmission through the atmosphere, T_{cell} is the wavelength-dependent optical transmission through a target gas channel of the radiometer, T_{filter} is the wavelength-dependent optical transmission through the filter, and $\partial\lambda$ is an increment of wavelength within the bandwidth of the infrared filter:

Equation (1) $$similarity \equiv \int_{\lambda_1}^{\lambda_2} T_{filter}(1-T_{atmosphere})(1-T_{cell})\partial\lambda .$$

11. A method as recited in claim 6, wherein the operation of determining the set of contrast data as a function of overlap regions within the spectral region is performed using Equation (1) below, wherein:

λ_2 and λ_1 define the bandwidth of the infrared filter, T_{atm} is the wavelength-dependent optical transmission through the atmosphere, T_{cell} is the wavelength-dependent optical transmission through a target gas channel of the radiometer, T_{filter} is the wavelength-dependent optical transmission through the filter, and $\partial\lambda$ is an increment of wavelength within the bandwidth of the infrared filter :

Equation (1)

$$contrast \equiv \int_{\lambda_1}^{\lambda_2} T_{filter}\,(T_{atmosphere})(1-T_{cell})\,\partial\lambda\,.$$

12. A method as recited in claim 6, wherein:

the operation of determining the set of similarity data as a function of overlap regions within the spectral region is performed using Equation (1) below; and

wherein the operation of determining the set of contrast data as a function of overlap regions within the spectral region is performed using Equation (2) below; and

wherein λ_2 and λ_1 define the bandwidth of the infrared filter, T_{atm} is the wavelength-dependent optical transmission through the atmosphere, T_{cell} is the wavelength-dependent optical transmission through a target gas channel of the radiometer, T_{filter} is the wavelength-dependent optical transmission through the

the

filter, and $\partial\lambda$ is an increment of wavelength within the bandwidth of the infrared filter:

Equation (1) $$similarity \equiv \int_{\lambda_1}^{\lambda_2} T_{filter}(1-T_{atmosphere})(1-T_{cell})\partial\lambda ,$$

Equation (2) $$contrast \equiv \int_{\lambda_1}^{\lambda_2} T_{filter}(T_{atmosphere})(1-T_{cell})\partial\lambda .$$